REMARKS

Claims 1-4, 6-13, 15-19 and 21-27 are pending in the present application. Claims 1-4, 6-8, 16, 19 and 21 are amended and claims 24-27 are added herein.

The Examiner rejected claims 1-4, 6-13, 15-19 and 21-23 under 35 U.S.C. § 103(a) as being unpatentable over Chooi, et al. (U.S. Patent No. 6,284,657) in view of applicants admitted prior art (AAPA) and Yi, et al. (U.S. Patent No. 5,900,163). Applicant respectfully traverses this rejection.

Applicant's attorney has carefully read the file, the references and the Examiner's Office Action and wishes to thank the Examiner for the obvious effort expended in the preparation of the Office Action. That being said, Applicant unfortunately also is compelled by the facts to regretfully disagree with the Examiner. Applicant's attorney firmly believes that the Examiner is incorrect concerning several positions in the Office Action as will be explained in detail below.

In any event, in an attempt to further the prosecution and allowance of the case,
Applicant's attorney has provided new independent claims 24, 25 and 26 that clearly eliminate
some of the very broad interpretations of the claims by the Examiner, and unintended by
Applicant, to determine if the Examiner believes there is any patentable subject matter at all and
the possibility of agreement, before Applicant's are compelled to proceed to the appellate stage.
Each of the new independent claims 24, 25 and 26 has the same basic elements as claims 1, 10
and 16. However, various of these claim elements are expanded with detailed versions of the
original elements in independent claims 1, 10 and 16. The expanded elements highlight the
issues of disagreement.

Therefore, a discussion of the new independent claims 24, 25 and 26 as they relate to the issues of disagreement are set out below. This is followed by rebuttal arguments to the Office

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Action rejecting all of the original claims. Further, since it is believed that the arguments provided in the August 25, 2003 response to the first Office Action were and still are accurate, proper and illustrate that the original claims were patentable, a slightly modified version of these arguments provided in the August 25th response, is again provided in this response.

Generally, a major part of the disagreement of the issues appears to be because the terms "etching" and "cleaning" have been used interchangeably rather than being used according to their precise definitions. Webster's New Universal Unabridged Dictionary, 2nd Edition, defines "etching" as "the act, art, process or practice of providing drawings or designs on plates of metal, glass, etc., by the use of acid." The Comprehensive Dictionary of Electrical Engineering, 1999 defines "etching" as, "A reactive process where material is removed from a semiconductor device or printed circuit board. Usually a photoresistive material is exposed through a photomask, and either a wet chemical process or dry plasma process is used to selectively remove material."

"Cleaning" on the other hand is defined in the Webster's dictionary as "the act of making clean."

The invention of the present application is clearly concerned with cleaning an already etched hole, trench or via to remove debris and chemical residue left by an earlier etching step and not etching as the term etching is commonly used. This is true even though the term "etch" or "etching" was used one time by Applicant specifically to describe a particular cleaning step.

The Chooi, et al. reference on the other hand, is clearly concerned with the steps of removing substantial amounts of material or etching trenches and spacers, not cleaning or removing debris from an already etched hole. In fact, the term cleaning is used only one time (col. 6, line 67) in the entire Chooi, et al. patent (including the abstract and the claims). Chooi, et al. simply is not concerned with cleaning an already etched hole.

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More specifically, the Examiner states that lines 37-43 teach "perform[ing] an RF plasma or etching for cleaning the hole 22/24...", however, this discussion in the Chooi, et al. patent irrebuttably teaches etching or removing substantial amounts of the non-metallic layer 15 to form spacers 19. The etching of the non-metallic layer 15 (shown in Fig. 5) to form spacers 19 is simply not the same as cleaning or removing surface oxide from the bottom of the hole that was formed during the process of etching the hole itself. In fact, Chooi, et al. deposits the spacer material and does a separate etching of the spacer material before the single mention of the word cleaning occurs in its Chooi, et al. patent. It is submitted, that the formation of the spacers covers and protects the sidewalls of the hole of the Chooi, et al. patent such that the organic sidewalls are not exposed and therefore particles cannot be displaced and redeposited as discussed and claimed in the present invention. Therefore, it is submitted that, other than the fact both processes are used to manufacture semiconductors, there is simply no relevance between the "admitted prior art discussion" of Fig. 1 and page 7, line 20 through page 8, line 7 as provided by the present application and the Chooi, et al. reference. In the admitted prior art and in the claims, the RF sputter is used to clean the surface oxide from the bottom of the hole that was formed during the etching of the hole or trench. There is not even a mention in Chooi, et al. that etching of the hole deposits a surface oxide at the bottom of the hole. In fact, according to Chooi, et al. there is still a further etching (not cleaning) step after the step of etching spacers. This step is shown in Fig. 6 and Fig. 7 of Chooi, et al. and discussed at col. 6, line 51. Thus, Chooi, et al. not only etches away or removes the passivation layer 12 but also penetrates into the conduction layer. Then, at Fig. 2 and at col. 6, line 65 through col. 7, line 4, Chooi, et al. teaches that after a conductor formed by sputtering (not shown) and the formation of a barrier layer 22, the one and only wet or dry cleaning step mentioned in the Chooi, et al. process takes place. Thus, the

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process of Chooi, et al. is simply not the same as the present process and there is no reason at all one skilled in the art would be encouraged to combine the prior art admitted in the present case with Chooi, et al. Furthermore, even if Chooi, et al. and the admitted prior art in the application were combined, the invention as taught and claimed is still in no way obvious much less taught by such a combination.

As to the Examiner's allegation that the prior art and Chooi, et al. teach that the sputter clean removes a surface oxide from the conductive layer, as discussed above, it is respectfully noticed that Chooi, et al. in no way even mentions a problem with surface oxide after etching of the hole or via and, consequently, there is no motivation whatsoever to combine Chooi, et al. and the admitted prior art so as to make the claims obvious. If Chooi, et al. doesn't even consider the removal of redeposited particles dislodged during the etching of its hole as a problem and never discusses the issue, where can the motivation possibly come from to combine?

With respect to the Examiner's allegations concerning claim 16, there is simply no teaching in Chooi, et al. of cleaning anything much less cleaning (or removing) surface oxide from the bottom of a just etched hole. In fact, Chooi, et al. instead proceeds to deposit a spacer material and then performs an etching of the spacer material before there is any mention of cleaning at all. Further, as discussed above, the use of a spacer material covering the sidewalls of the hole means that particles of organic material cannot be dislodged from the sidewalls of the hole and redeposited on the bottom of the hole by the sputter clean process. Therefore, the Chooi, et al. reference is believed to be substantially irrelevant to the present invention as claimed with or without combining it with the admitted prior art.

As to the Examiner's discussion of the arguments made in the August 25, 2003 response of Applicant to the Office Action that Yi, et al. is in fact used to reject the independent claims 1,

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10 and 16 even though never directly applied against these claims, Applicant still disagrees, but sees no importance of this matter to the present case. With all due respect, in the undersigned attorney's many years of experience, no Examiner has ever insisted an independent claim was rejected as unpatentable over a reference not directly applied to the independent claim simply because the reference was used to reject one or more of the dependent claims. If the Examiner wants to reject the independent claims 1, 10 and 16, on the Yi, et al. reference, all he needs to do is indicate what aspects of the Yi, et al. reference he is applying to elements of the independent claims 1, 10 and 16. Applying Yi, et al. to dependent claims simply does not apply Yi, et al. to the independent claims.

As to the Examiner's argument that Chooi, et al. utilizes a plasma of argon and nitrogen "for etching or cleaning the hole", Applicant's attorney reiterates that cleaning or removing debris such as redeposited particles dislodged from the sidewalls of the hole is substantially different than actual etching or removing substantial material to form the spacers and the hole itself. The Examiner's statement that Chooi, et al. RF plasma acts as a physical sputter clean does not make it so and certainly does not make it a cleaning process for removing dislodged and redeposited organic particles as taught and claimed by the present application.

The Examiner states that the Chooi, et al. etching process is broadly interpreted as a cleaning process. Whether or not etching can be considered a broad interpretation of the word cleaning is not relevant since the application is clearly referring to the specific act of cleaning or removing debris, etc., from the hole, not the act of etching a spacer or the hole itself where a substantial amount of material is removed.

Further, as was thoroughly discussed in the August 25, 2003 response, independent claim 1 specifically recites "performing a radio frequency (RF) sputter clean of the hole; and

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performing an anisotropic, ion enhanced etch of organic material deposited in the hole at least partially during the sputter clean." To establish a prima facie case of obviousness, three basic criteria must be met. See M.P.E.P. § 2143. First, there must be some suggestion or motivation, either in the references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify the reference or to combine reference teachings. Second, there must be a reasonable expectation of success. Finally, the prior art references when combined must teach or suggest <u>all</u> of the claim limitations. Applicant respectfully asserts that none of the three criteria are met.

With respect to the third criterion, none of the cited prior art, taken alone or in combination, teaches or suggests performing an anisotropic, ion enhanced etch of organic material at least partially during an RF sputter clean. The admitted prior art states that, after a hole is etched in an organic interlayer dielectric (ILD), it is known to perform an RF sputter clean of the hole (page 2, line 20). However, there clearly is no teaching or suggestion of performing an anisotropic, ion enhanced etch of organic material at least partially during the RF sputter clean process.

Likewise, Chooi, et al. does not teach or suggest performing an anisotropic, ion enhanced etch of organic material at least partially during an RF sputter clean process. The Examiner admits that Chooi, et al. does not expressly teach that the argon acts as a sputter clean function. The Examiner also effectively admits that Chooi, et al. does not expressly teach the anisotropic, ion enhanced etch of organic material limitation because the Examiner only states that Chooi, et al. "inherently teach" that nitrogen in the plasma functions as ion enhanced organic etch. In fact, Chooi, et al. never even addresses performing a cleaning process step on the trench or via, let

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alone discloses a sputter clean in combination with an anisotropic, ion enhanced organic etch.

As mentioned above, the word "clean" or "cleaning" is only used one time in Chooi, et al.

Specifically, a first section of Chooi, et al., col. 6, lines 37-43, cited by the Examiner with respect to plasma processing, describes the etch process shown in Fig. 6. This etch is performed on non-metallic layer 15, which "can be formed of a material such as silicon carbide, boron nitride, carbon nitride boron carbon nitride or boron carbide" (col. 6, lines 29-32). Firstly, this section discloses an etch process (not a cleaning process) for etching layer 15 to remove substantial amounts of material so there is no teaching or suggestion of a sputter clean process by Chooi, et al., let alone an RF sputter clean. Secondly, the formed spacer protects or covers the organic layer so there cannot be displaced organic material, or particles. Consequently, Chooi, et al. cannot possibly teach or suggest an anisotropic ion enhanced etch of such organic material displaced from the sidewalls. In other words, the etch of Chooi, et al. cited by the Examiner cannot perform a cleaning or an etch of organic material redeposited at the bottom of its hole if there is no organic material to clean.

A second section of Chooi, et al., col. 9, lines 48-49, cited by the Examiner with respect to plasma processing, describes the treatment process shown in Fig. 16. There is also a similar process performed subsequently in Fig 20. This plasma treatment process forms a layer of "pseudo-carbon nitride" on the exposed surface of the dielectric layer (col. 9, lines 52-61). Firstly, this process is actually forming a layer, which is opposite of etching or removing a layer, and is completely unrelated to the sputter clean and organic etch of the claimed invention. Secondly, the Examiner is combining unrelated processes from two separate embodiments disclosed by Chooi, et al. in rejecting claim 1. The first plasma process is used in the first embodiment of Chooi, et al. to etch a non-metallic layer, while the second plasma process is used

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in the third embodiment of Chooi, et al. to form a layer of pseudo-carbon nitride. However, in both cases a layer is formed that protects or covers the organic sidewalls of the hole or trench. Therefore, organic particles cannot be dislodged from the sidewalls of the hole and deposited on the bottom of the hole since the organic material is not exposed. Further, because these processes perform effectively opposite functions, for at least these two cases the Examiner cannot properly combine the elements of these processes.

With respect to the first criterion of prima facie obviousness, motivation to modify/combine, the Examiner admits that Chooi, et al. does not expressly teach that the argon acts as a sputter clean function. The Examiner then attempts to cure this deficiency by introducing the prior art admitted by Applicant, and alleging that the admitted prior art discloses that knowledge generally available to one of ordinary skill in the art provides the requisite motivation. In particular, the Examiner states, "One of the ordinary skill in the art, however, would have recognized that the role of argon in the plasma functions as the sputter clean because argon has been widely used as etching gas in physical sputter cleaning practice, as evidenced by AAPA."

It is well settled, however, that the prior art must suggest the desirability of the claimed invention, see M.P.E.P. § 2143.01, and the Examiner's stated motivation does not provide such a suggestion. In addition, a full reading of the admitted prior art shows that the cleaning process is performed after a hole is etched, but before a liner or plug is formed (page 2, lines 11-16). The cleaning process is used to remove an oxide formed on the lower layer, as well as any other residue left from the etch chemistry used to form the hole (Id.). Thus, while the admitted prior art may acknowledge that it is known to etch a hole, then clean the hole, then form a liner or plug in the hole, there is no teaching or suggestion in the cited references that an etching process for

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forming a hole or etching a layer of material covering the sidewalls of the hole can be used to clean the hole as well. Chooi, et al. only discloses etching of the trench or via, or layer in the trench or via, and then immediately forming an additional layer that covers the surface of the trench or via. Chooi, et al. completely ignores any cleaning step that may be performed between the etching of a trench, via or layer, and the formation of a subsequent layer in the trench or via. In fact, Chooi, et al. does not even suggest that surface oxide may be deposited in the hole such that it must be removed. It is not even known whether the etching process Chooi, et al. might use is capable of leaving a layer of surface oxide on the bottom of the hole. Accordingly, there is no motivation to modify the etch processes disclosed by Chooi, et al. to perform the RF sputter clean/etch process of organic material as required by the claimed invention.

Independent claim 10 specifically recites "sputter cleaning the bottom of the hole with the physical etch component [of a plasma,] and anisotropically removing organic material from the bottom of the hole with the chemical etch component" of the plasma. Applicant respectfully asserts that the references lack proper motivation to modify/combine in addition to lacking all the claim limitations.

None of the cited prior art, taken alone or in combination, teaches or suggests sputter cleaning the bottom of a hole with the physical etch component of a plasma, and anisotropically removing organic material from the bottom of the hole with the chemical etch component of the plasma. The admitted prior art states that, after a hole is etched in an organic interlayer dielectric (ILD), it is known to perform an RF sputter clean of the hole (page 2, line 20). The admitted prior art, however, clearly does not teach or suggest performing an anisotropic, ion enhanced organic etch at least partially during the RF sputter clean process.

Likewise, Chooi, et al. does not teach or suggest sputter cleaning the bottom of a hole with the physical etch component of a plasma, and anisotropically removing organic material from the bottom of the hole with the chemical etch component of the plasma. The Examiner admits that Chooi, et al. does not expressly teach that the argon acts as a sputter clean function. The Examiner also effectively admits that Chooi, et al. does not expressly teach anisotropically removing organic material from the bottom of the hole because the Examiner only states that Chooi, et al. "inherently teach" that nitrogen in the plasma functions as ion enhanced organic etch. In fact, Chooi, et al. never even addresses performing a cleaning process step on the trench or via, let alone discloses sputter cleaning the bottom of a hole with the physical etch component of a plasma, and anisotropically removing organic material from the bottom of the hole with the chemical etch component of the plasma.

Specifically, a first section of Chooi, et al., col. 6, lines 37-43, cited by the Examiner with respect to plasma processing, describes the etch process shown in Fig. 6. This etch is performed on non-metallic layer 15, which "can be formed of a material such as silicon carbide, boron nitride, carbon nitride boron carbon nitride or boron carbide" (col. 6, lines 29-32). Firstly, this section discloses an etch process (not a cleaning process) for etching layer 15, so there is no teaching or suggestion of a sputter clean process by Chooi, et al. Secondly, this step forms spacers that cover or protect the sidewalls of the hole such that there is not exposed organic material or displaced organic material on layer 15, so Chooi, et al. cannot possibly teach or suggest anisotropically removing organic material from the bottom of the hole. In other words, the etch of Chooi, et al. cited by the Examiner cannot perform an etch of organic material on the bottom of the hole if there is no organic material to etch.

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A second section of Chooi, et al., col. 9, lines 48-49, cited by the Examiner with respect to plasma processing, describes the treatment process shown in Fig. 16. There is also a similar process performed subsequently in Fig 20. This plasma treatment process forms a layer of "pseudo-carbon nitride" on the exposed surface of the dielectric layer (col. 9, lines 52-61).

Firstly, this process is actually forming a layer, which protects and covers the sidewalls.

Formation of the layer is the opposite of etching a layer, and is completely unrelated to the sputter clean and organic etch of the claimed invention. Secondly, the Examiner is apparently combining unrelated processes from two separate embodiments disclosed by Chooi, et al. in rejecting claim 1. The first plasma process is used in the first embodiment of Chooi, et al. to etch a non-metallic layer, while the second plasma process is used in the third embodiment of Chooi, et al. to form a pseudo-carbon nitride layer. Because these processes perform effectively opposite functions, the Examiner cannot properly combine the elements of these processes.

With respect to the first criterion of prima facie obviousness, motivation to modify/combine, the Examiner admits that Chooi, et al. does not expressly teach that the argon acts as a sputter clean function. The Examiner then attempts to cure this deficiency by introducing the admitted prior art, and alleging that the admitted prior art discloses that knowledge generally available to one of ordinary skill in the art provides the requisite motivation. In particular, the Examiner states, "One of the ordinary skill in the art, however, would have recognized that the role of argon in the plasma functions as the sputter clean because argon has been widely used as etching gas in physical sputter cleaning practice, as evidenced by AAPA." Even if this is so, Applicant respectfully submits that there still is no motivation to combine.

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It is well settled that the prior art must suggest the desirability of the claimed invention (M.P.E.P. § 2143.01). However, the Examiner's stated motivation does not provide such a suggestion. A full reading of the admitted prior art shows that the cleaning process is performed after a hole is etched, but before a liner or plug is formed (page 2, lines 11-16). The cleaning process may remove an oxide formed on the lower layer at the bottom of the hole, as well as other residue left from the etch chemistry used to form the hole (ld.). Thus, while the admitted prior art acknowledges that it is known to etch a hole, then clean the hole, then form a liner or plug in the hole, there is no teaching or suggestion in the cited references that an etching process for forming a hole or etching a layer in the hole can also be used to clean redeposited organic material from the bottom of the hole as well. Chooi, et al. only discloses etching of the trench or via, or of a layer in the trench or via, and then immediately forming an additional non-metallic layer over the surface of the trench or via. Chooi, et al. completely ignores any cleaning step that may be performed between etching a trench or via, and the formation of a subsequent layer over the surface of the trench or via. Accordingly, there is no motivation to modify the etch processes disclosed by Chooi, et al. to perform the sputter clean/organic etch process required by the claimed invention.

Independent claim 16 specifically recites "performing an RF sputter clean of a bottom of the hole; performing an anisotropic, ion enhanced chemical organic etch of the hole, wherein the etch is performed at least partially during the RF sputter clean." Without conceding the second criterion of prima facie obviousness, Applicant respectfully asserts that the references lack proper motivation to modify/combine in addition to lacking all the claim limitations.

With respect to the third criterion, none of the cited prior art, taken alone or in combination, teaches or suggests performing an anisotropic, ion enhanced chemical organic etch

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at least partially during an RF sputter clean of the bottom of a hole. The admitted prior art states that, after a hole is etched in an organic interlayer dielectric (ILD), it is known to perform an RF sputter clean of the hole (page 2, line 20). The admitted prior art, however, clearly does not teach or suggest performing an anisotropic, ion enhanced chemical organic etch at least partially during the RF sputter clean of the bottom of the hole.

Likewise, Chooi, et al. does not teach or suggest performing an anisotropic, ion enhanced chemical organic etch at least partially during an RF sputter clean of the bottom of a hole. The Examiner admits that Chooi, et al. does not expressly teach that the argon acts as a sputter clean function. The Examiner also effectively admits that Chooi, et al. does not expressly teach the anisotropic, ion enhanced chemical organic etch component because the Examiner only states that Chooi, et al. "inherently teach" that nitrogen in the plasma functions as ion enhanced organic etch of the organic material. In fact, Chooi, et al. never even addresses performing a cleaning process step on the trench or via, let alone discloses a sputter clean in combination with an anisotropic, ion enhanced chemical organic etch to remove particles dislodged from the sidewalls and redeposited on the bottom of the hole.

Specifically, a first section of Chooi, et al., col. 6, lines 37-43, cited by the Examiner with respect to plasma processing, describes the etch process shown in Fig. 6. This etch is performed on non-metallic layer 15, which "can be formed of a material such as silicon carbide, boron nitride, carbon nitride boron carbon nitride or boron carbide" (col. 6, lines 29-32). Firstly, this section discloses an etch process, not a cleaning process, for etching layer 15, so there is no teaching or suggestion of a sputter clean process by Chooi, et al., let alone an RF sputter clean. Secondly, the spacer protects and covers the sidewalls, so there is not an exposed organic layer or displaced organic material on layer 15, so Chooi, et al. cannot possibly teach or suggest an

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anisotropic ion enhanced chemical organic etch. In other words, the etch of Chooi, et al. cited by the Examiner cannot perform an organic etch if there is no organic material to etch.

A second section of Chooi, et al., col. 9, lines 48-49, cited by the Examiner with respect to plasma processing, describes the treatment process shown in Fig. 16. There is also a similar process performed subsequently in Fig 20. This plasma treatment process forms a layer of "pseudo-carbon nitride" on the exposed surface of the dielectric layer (col. 9, lines 52-61).

Firstly, this process is actually forming a protective layer on the sidewalls, which is the opposite of etching a layer, and is completely unrelated to the sputter clean and organic etch of the claimed invention. Secondly, the Examiner is apparently combining unrelated processes from two separate embodiments disclosed by Chooi, et al. in rejecting claim 1. The first plasma process is used in the first embodiment of Chooi, et al. to etch a non-metallic layer to form spacers, while the second plasma process is used in the third embodiment of Chooi, et al. to form a layer of pseudo-carbon nitride to protect the sidewalls. Because these processes prevent the deposition of displaced organic particles at the bottom of the hole, while at the same time performing effectively opposite functions, the Examiner cannot properly combine the elements of these processes.

With respect to the first criterion of prima facie obviousness, motivation to modify/combine, the Examiner admits that Chooi, et al. does not expressly teach that the argon acts as a sputter clean function. The Examiner then attempts to cure this deficiency by introducing the admitted prior art, and alleging that the admitted prior art discloses that knowledge generally available to one of ordinary skill in the art provides the requisite motivation. In particular, the Examiner states: "One of ordinary skill in the art, however, would have recognized that the role of argon in the plasma functions as the sputter clean because argon

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has been widely used as etching gas in physical sputter cleaning practice, as evidenced by AAPA."

It is well settled, however, that the prior art must suggest the desirability of the claimed invention, see M.P.E.P. § 2143.01, and the Examiner's stated motivation does not provide such a suggestion. A full reading of the admitted prior art shows that the cleaning process is performed after a hole is etched, but before a liner or plug is formed (page 2, lines 11-16). The cleaning process may remove an oxide formed on the lower layer, as well as other residue left from the etch chemistry used to form the hole (Id.). Thus, while the admitted prior art acknowledges that it is known to etch a hole, then clean the hole, then form a liner or plug in the hole, there is no teaching or suggestion in the cited references that an etching process for forming a hole or etching a layer in the hole can be used to clean the hole as well. Chooi, et al. only discloses etching of the trench or via, or of a layer in the trench or via, and then immediately forming an additional layer in the trench or via. Chooi, et al. completely ignores any cleaning step that may be performed between the etching a trench, via or layer, and the formation of a subsequent layer in the trench or via. Accordingly, there is no motivation to modify the etch processes disclosed by Chooi, et al. to perform the RF sputter clean/organic etch process required by the claimed invention.

Finally, with respect to the Examiner's penultimate paragraph, Applicant has in no way attempted to show non-obviousness by attacking the references individually as suggested by the Examiner. Applicant's position is that clearly there has been no motivation to combine and that such motivation was not established in the previous action as stated by the Examiner and was not established in its instant Office Action.

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Applicant has made a diligent effort to place the claims in condition for allowance. However, should there remain unresolved issues that require adverse action, it is respectfully requested that the Examiner telephone James C. Kesterson, Applicant's Attorney, at 972-732-1001 so that such issues may be resolved as expeditiously as possible.

Respectfully submitted,

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